TABLE OF CONTENTS

Section	on F	age
List Act List	t of Figures t of Tables knowledgments t of Acronyms ecutive Summary	. ix xiii xvii
1	Introduction 1.1 Historical Perspective 1.2 Purpose 1.3 Objectives 1.4 Relationship of Manual to Other Guidance Documents 1.5 Organization of this Manual	1-1 1-3 1-4 1-6
2	Monitoring Strategy 2.1 Screening Studies (Tier 1)	2-4
3	Target Species 3.1 Purpose of Using Target Species 3.2 Criteria for Selecting Target Species 3.3 Freshwater Target Species 3.3.1 Target Finfish Species 3.3.2 Target Turtle Species 3.4 Estuarine/Marine Target Species 3.4.1 Target Shellfish Species 3.4.2 Target Finfish Species	3-1 3-2 3-3 3-5 3-12 3-16 3-24
4	Target Analytes 4.1 Recommended Target Analytes 4.2 Selection of Target Analytes 4.3 Target Analyte Profiles 4.3.1 Metals 4.3.2 Organochlorine Pesticides 4.3.3 Organophosphate Pesticides 4.3.4 Chlorophenoxy Herbicides 4.3.5 Polycyclic Aromatic Hydrocarbons (PAHs) 4.3.6 Polychlorinated Biphenyls (Total)	4-1 4-5 4-5 4-13 4-21 4-25 4-26 4-29

Section		
	4.4 Target Analytes under Evaluation	
	Screening Values for Target Analytes	5-2 5-3 5-3
	Value Equations	. 5-5 5-14 5-14
	Field Procedures 6.1 Sampling Design 6.1.1 Screening Studies (Tier 1) 6.1.2 Intensive Studies (Tier 2)	. 6-1 . 6-2
	6.2 Sample Collection	6-22 6-22 6-29
	6.3 Sample Handling	6-39 6-39 6-47 6-48
7	Laboratory Procedures I—Sample Handling	. 7-1 . 7-3 . 7-3 . 7-7 7-17
	7.3 Sample Distribution	7-30 7-30
	Laboratory Procedures II—Sample Analyses	. 8-1 . 8-1

Section	on	Page
	8.2 Analytical Methods	8-3 8-6
	8.3 Quality Assurance and Quality Control Considerations 8.3.1 QA Plans	. 8-14 . 8-14
	8.4 Documentation and Reporting of Data	8-49 8-49
9	Data Analysis and Reporting	9-1 9-1
	9.2 Data Reporting	9-3
10	Literature Cited	. 10-1
Apper	ndix	
Α	Use of Individual Samples in Fish Contaminant Monitoring Programs	A-1
В	Fish and Shellfish Species for which State Consumption Advisories Have Been Issued	B-1
С	Target Analytes Analyzed in National or Regional Monitoring Programs	. C-1
D	Pesticides and Herbicides Recommended as Target Analytes	. D-1
Ε	Target Analyte Dose-Response Variables and Associated Information	E-1
F	Quality Assurance and Quality Control Guidance	F-1
G	Recommended Procedures for Preparing Whole Fish Composite Homogenate Samples	. G-1
Н	General Procedures for Removing Edible Tissues from Freshwater Turtles	. H-1

Appendix		
1	General Procedures for Removing Edible Tissues from Shellfish I-1	
J	Comparison of Target Analyte Screening Values (SVs) with Detection and Quantitation Limits of Current Analytical Methods J-1	
K	A Recommended Method for Inorganic Arsenic Analysis K-1	
L	Sources of Recommended Reference Materials and Standards L-1	
M	Statistical Methods for Comparing Samples: Spatial and Temporal Considerations	

LIST OF FIGURES

Number Page		
2-1	Recommended strategy for State fish and shellfish contaminant monitoring programs	. 2-2
3-1	Geographic range of the common snapping turtule (<i>Chelydra serpentina</i>)	3-13
3-2	Geographic distributions of three bivalve species used extensively in national contaminant monitoring programs	
4-1 4-2	States issuing fish and shellfish advisories for mercury States issuing fish and shellfish advisories for chlordane	
4-2 4-3	States issuing fish and shellfish advisories for PCBs	
4-4	States issuing fish and shellfish advisories for dioxin/furans	
6-1 6-2	Example of a sample request form	. 6-3
6-3	program—screening study	6-32
00	program—screening study	6-33
6-4	Example of a field record for fish contaminant monitoring	
	program—intensive study	6-34
6-5	Example of a field record for shellfish contaminant monitoring	C 2C
6-6	program—intensive study	
6-7	Example of a chain-of-custody tag or label	
6-8	Example of a chain-of-custody record form	
6-9	Recommended measurements of body length and size for	
	fish, shellfish, and turtles	6-44
7-1	Preparation of fish fillet composite homogenate samples	. 7-8
7-2	Example of a sample processing record for fish contaminant	
	monitoring program—fish fillet composites	
7-3	Illustration of basic fish filleting procedure.	
7-4 7-5	Preparation of individual turtle homogenate samples Example of a sample processing record for a contaminant	7-18
1-5	monitoring program—individual turtle samples	7-19
7-6	Illustration of basic turtle resection procedure	
7-7	Preparation of shellfish edible tissue composite homogenate	_ _
	samples	7-26

Number	
7-8	Example of a sample processing record for shellfish contaminant monitoring program—edible tissue composites 7-28
7-9	Example of a fish and shellfish monitoring program sample aliquot record
7-10	Example of a fish and shellfish monitoring program sample transfer record
8-1	Recommended contents of analytical standard operating procedures (SOPs)
9-1	Recommended data reporting requirements for screening and intensive studies

LIST OF TABLES

N	Number Page		
	2-1	Recommended Strategy for State Fish and Shellfish Contaminant Monitoring Programs	. 2-5
	3-1 3-2	Recommended Target Species for Inland Fresh Waters Recommended Target Species for Great Lakes Waters	
	3-3	Comparison of Freshwater Finfish Species Used in Several National Fish Contaminant Monitoring Programs	. 3-6
	3-4 3-5	Freshwater Turtles Recommended for Use as Target Species Average Fish Tissue Concentrations of Xenobiotics for Major Finfish Species Sampled in the National Study of Chemical	. 3-7
	3-6	Residues in Fish	. 3-8
	3-7	Chemical Residues in Fish	. 3-9
		Consumption Advisories	3-10
	3-8	Principal Freshwater Turtle Species Cited in State Consumption Advisories	3-14
	3-9	Summary of Recent Studies Using Freshwater Turtles as Biomonitors of Environmental Contamination	3-15
	3-10	Recommended Target Species for Northeast Atlantic	
	3-11	Estuaries and Marine Waters (Maine through Connecticut) Recommended Target Species for Mid-Atlantic Estuaries and	
	3-12	Marine Waters (New York through Virginia)	3-18
		Estuaries and Marine Waters (North Carolina through Florida)	3-19
	3-13	Recommended Target Species for Gulf of Mexico Estuaries and Marine Waters (West Coast of Florida through Texas)	3-20
	3-14	Recommended Target Species for Pacific Northwest Estuaries and Marine Waters (Alaska through Oregon)	3-21
	3-15	Recommended Target Species for Northern California Estuaries and Marine Waters (Klamath River through Morro	
	3-16	Bay)	3-22
		Estuary)	3-23
	3-17	Sources of Information on Commercial and Sportfishing Species in Various Coastal Areas of the United States	3-25

١	Number Pa		
	3-18	Estuarine/Marine Species Used in Several National Fish and Shellfish Contaminant Monitoring Programs	3-26
	3-19	Principal Estuarine/Marine Fish and Shellfish Species Cited in State Consumption Advisories	
	4-1	Recommended Target Analytes	. 4-2
	4-2 4-3	Contaminants Resulting in Fish and Shellfish Advisories Polychlorinated Biphenyl (PCB) Congeners Recommended	. 4-4
	4-4	for Quantitation as Potential Target Analytes	
		raiget Analytes	4-30
	5-1	Recommended Values for Mean Body Weights (BWs) and Fish Consumption Rates (CRs) for Selected Subpopulations	. 5-6
	5-2	Dose-Response Variables and Recommended Screening Values (SVs) for Target Analytes	5-8
	5-3	Example Screening Values (SVs) for Various Subpopulations and Risk Levels (RLs)	
	5-4	Estimated Order of Potential Potencies of Selected PAHs	
	5-5	Toxicity Equivalency Factors (TEFs) for Tetra- through Octa- Chlorinated Dibenzo-p-Dioxins and Dibenzofurans	5-20
	6-1	Values of $[2/n^2m^2(n-1)]^{1/2}$ for Various Combinations of	
	6-2	n and m	
	6-3	Specified Assumptions	
	6-4 6-5	Summary of Shellfish Sampling Equipment	6-25
	6.6	and Shellfish Contaminant Monitoring Programs	
	6-6 6-7	Safety Considerations for Field Sampling Using a Boat Recommendations for Preservation of Fish, Shellfish, and Turtle Samples from Time of Collection to Delivery at the	0- ∠8
		Processing Laboratory	6-49
	7-1	Recommendations for Container Materials, Preservation, and Holding Times for Fish, Shellfish, and Turtle Tissues from	
	7-2	Receipt at Sample Processing Laboratory to Analysis Weights (g) of Individual Homogenates Required for	. 7-4
	7.0	Screening Study Composite Homogenate Sample	7-16
	7-3	Recommended Sample Aliquot Weights and Containers for Various Analyses	7-31

lumber Pa		
8-1	Contract Laboratories Conducting Dioxin/Furan Analyses in Fish and Shellfish Tissues	0 2
8-2	Current References for Analytical Methods for Contaminants	0-2
0-2	in Fish and Shellfish Tissues	8-4
8-3	Recommended Analytical Techniques for Target Analytes	
8-4	Range of Detection and Quantitation Limits of Current	
8-5	Analytical Methods for Recommended Target Analytes 8 Approximate Range of Costs per Sample for Analysis of	3-11
	Recommended Target Analytes	3-13
8-6	Recommended Quality Assurance and Quality Control	
	Samples	3-18
8-7	Minimum Recommended QA and QC Samples for Routine	
8-8	Analysis of Target Analytes	
9-1	Hypothetical Cadmium Concentrations (ppm) in Target	
	Species A at Three River Locations	9-6

ACKNOWLEDGMENTS

This report was prepared by the U.S. Environmental Protection Agency, Office of Water, Fish Contamination Section. The EPA Project Manager for this document was Jeffrey Bigler who provided overall project coordination as well as technical direction. EPA was supported in the development of this document by the Research Triangle Institute (RTI) and Tetra Tech, Inc. (EPA Contract Number 68-C3-0374). Pat Cunningham of RTI was the contractor's Project Manager. Preparation of the First and Second Editions of this guidance was facilitated by the substantial efforts of the numerous Workgroup members and reviewers listed below. These individuals representing EPA Headquarters, EPA Regions, State and Federal agencies, Native American groups and others provided technical information, reviews, and recommendations throughout the preparation of this document. Participation in the review process does not imply concurrence by these individuals with all concepts and methods described in this document.

FISH CONTAMINANT WORKGROUP

EPA Headquarters Staff

Charles Abernathy
Thomas Armitage

Leftrov Piglor

EPA/Office of Water

EPA/Office of Water

Jeffrey Bigler EPA/Office of Water (Workgroup Chairman)
Carin Bisland EPA/Office of Water

Dennis Borum EPA/Office of Water Robert Cantilli EPA/Office of Water Julie Du EPA/Office of Water Richard Hoffman EPA/Office of Water Clyde Houseknecht EPA/Office of Water Henry Kahn EPA/Office of Water Amal Mahfouz EPA/Office of Water Michael Kravitz EPA/Office of Water EPA/Office of Water Elizabeth Southerland Margaret Stasikowski EPA/Office of Water Irene Suzukida-Horner EPA/Office of Water Elizabeth Tam EPA/Office of Water William Telliard EPA/Office of Water Charles White EPA/Office of Water Jennifer Orme Zavala EPA/Office of Water

Tina Levine EPA/Office of Pesticide Programs
Michael Metzger EPA/Office of Pesticide Programs
Richard Whiting EPA/Office of Pesticide Programs

Jacqueline Moya EPA/Office of Health and Environmental

Assessment

Other EPA Office Staff

David DeVault EPA/Great Lakes National Program Office Brian Melzian EPA/Office of Reserach and Development-

Narragansett, RI

John Paul EPA/Office of Research and Development-

Narragansett, RI

Dennis McMullen EPA/Environmental Monitoring and

Systems Laboratory-Cincinnati, OH

Laurence Burkhard EPA/Office of Research and Development-

Duluth, MN

Michael Dourson EPA/Office of Health and Environmental

Assessment-Cincinnati, OH

Donald Klemm EPA/Office of Health and Environmental

Assessment-Cincinnati, OH

EPA Regional Staff

Charles Kanetsky
Jerry Stober
Region 4
Peter Redmon
Diane Evans
Philip Crocker
Region 7
Bruce Herbold
Region 3
Region 4
Region 5
Region 6
Region 7

Other Federal Agency Staff

Michael Bolger FDA
Leon Sawyer FDA
Lee Barclay FWS
Frank De Luise FWS
Donald Steffeck FWS

Jerry Schulte **ORSANCO** Adriana Cantillo NOAA Maxwell Eldridge NOAA Betty Hackley NOAA Alicia Jarboe NOAA Bruce Morehead NOAA Don Dycus TVA J. Kent Crawford **USGS**

State Agency Staff

Robert Cooner Alabama Brian Hughes Alabama William Keith Arkansas Thomas McChesney Arkansas Randall Mathis Arkansas Gerald Pollock California Robert McConnell Colorado Richard Green Delaware Eldert Hartwig Florida Randall Manning Georgia Robert Flentge Illinois C. Lee Bridges Indiana **Emelise Cormier** Louisiana Albert Hindrichs Louisiana Elaine Sorbet Louisiana Deirdre Murphy Maryland Jack Schwartz Massachusetts John Hesse Michigan Richard Powers Michigan Lisa Williams Michigan Minnesota Pamela Shubat Alan Buchanan Missouri David Tunink Nebraska Donald Normandeau New Hampshire

Paul Hauge New Hampsnir
Paul Hauge New Jersey
Lawrence Skinner New York
Ken Eagleson North Carolina
Jay Sauber North Carolina
Luanne Williams North Carolina
Michael Ell North Dakota
Martin Schock North Dakota

Abul Anisuzzaman Ohio
Gene Foster Oregon
Barbara Britton Texas
Peter Sherertz Virginia
Ram Tripathi Virginia
Jim Amrhein Wisconsin
Bruce Baker Wisconsin

Other Organizations

James Wiener American Fisheries Society
Deborah Schwackhamer University of Minnesota

Alvin Braswell North Carolina State Museum of Natural Science

J. Whitfield Gibbons University of Georgia Savannah River

Ecology Laboratory

LIST OF ACRONYMS

AFS American Fisheries Society

ANOVA Analysis of Variance

ATSDR Agency for Toxic Substances and Disease Registry

BCF bioconcentration factor

BW body weight

CERCLA Comprehensive Environmental Response, Compensation, and

Liability Act

COC chain-of-custody
CR consumption rate

CRADAs Cooperative Research and Development Agreements

CSOs combined sewer overflows

DOT U.S. Department of Transportation

EPA U.S. Environmental Protection Agency

FDA U.S. Food and Drug Administration

FWS U.S. Fish and Wildlife Service

 γ -BHC benzene hexachloride γ -HCH hexachlorocyclohexane

GC/ECD gas chromatography/electron capture detection

GC/MS gas chromatography/mass spectrometry

GPS Global Positioning System

HRGC/MRMS high-resolution gas chromatography/high-resolution mass

spectrometry

IRIS Integrated Risk Information System

MDL method detection limit
MQL method quantitation limit

NAS National Academy of Sciences

NCBP National Contaminant Biomonitoring Program

NCR no-carbon-required

NFTDR National Fish Tissue Data Repository

NIST National Institute of Standards and Technology
NOAA National Oceanic and Atmospheric Administration

OAPCA Organotin Antifouling Paint Control Act

OAQPS Office of Air Quality Planning and Standards

ODES Ocean Discharge Evaluation System

ODW Office of Drinking Water

OHEA Office of Health and Environmental Assessment

OPPs Office of Pesticide Programs

ORSANCO Ohio River Valley Water Sanitation Commission

PAHs polycyclic aromatic hydrocarbons

PCBs polychlorinated biphenyls

PCDDs polychlorinated dibenzo-p-dioxins

PCDFs polychlorinated dibenzofurans

PEC potency equivalency concentration
PNAs polynuclear aromatic hydrocarbons

PTFE polytetrafluoroethylene

QA quality assurance

QC quality control

RCRA Resource Conservation and Recovery Act

RfD reference dose

RPs relative potencies

SF slope factor

SOPs standard operating procedures

SVs screening values

2,4,5-T 2,4,5-trichlorophenoxyacetic acid

2,3,7,8-TCDD 2,3,7,8-tetrachlorodibenzo-p-dioxin

2,3,7,8-TCDF 2,3,7,8-tetrachlorodibenzofuran

2,4,5-TCP 2,4,5-trichlorophenol

TECs toxicity equivalent concentrations

TVA Tennessee Valley Authority

USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
WHO	World Health Organization